



(19) Europäisches Patentamt

European Patent Office

Office européen des brevets



(11) EP 0 704 066 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
17.10.2001 Bulletin 2001/42

(51) Int Cl.⁷: **G02B 5/18, G02B 27/44,
B44F 1/12, B42D 15/10,
B42D 209/00**

(21) Application number: **94916832.2**

(86) International application number:
PCT/AU94/00279

(22) Date of filing: **25.05.1994**

(87) International publication number:
WO 94/28444 (08.12.1994 Gazette 1994/27)

(54) MULTIPLE IMAGE DIFFRACTIVE DEVICE

DIFFRAKTIONSVORRICHTUNG MIT MEHREREN ABBILDUNGEN

DISPOSITIF DIFFRACTEUR A IMAGES MULTIPLES

(84) Designated Contracting States:
CH DE FR GB LI

(74) Representative: **Ertl, Nicholas Justin et al
Elkington and Fife,
Prospect House,
8 Pembroke Road
Sevenoaks, Kent TN13 1XR (GB)**

(30) Priority: **25.05.1993 AU PL900093**

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(43) Date of publication of application:
03.04.1996 Bulletin 1996/14

• **PATENT ABSTRACTS OF JAPAN, P-1057, page
1; & JP,A,2 072 320 (TOPPAN PRINTING CO.
LTD), 12 March 1990.**

(73) Proprietor: **COMMONWEALTH SCIENTIFIC AND
INDUSTRIAL RESEARCH ORGANISATION
Campbell, ACT 2612 (AU)**

(72) Inventor: **LEE, Robert, Arthur
East Burwood, VIC 3125 (AU)**

EP 0 704 066 B1

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Description**Field of the Invention**

[0001] This invention relates to diffractive devices and to their manufacture and has particular though not exclusive application to the provision of optically variable security diffractive devices which may be adapted for affixment to or incorporation in, for example, currency notes, credit cards, charge cards, share certificates and the like.

Background Art

[0002] The present applicant's international patent publication WO91/03747 (application PCT/AU90/00395) proposes a diffraction grating structure comprised of a multiplicity of pixels which are individual optical diffraction gratings so that the pixellated diffraction grating when illuminated generates an optically variable image. The applicant's pixellated diffraction gratings utilising curved line grating pixels have become known by the trademark Pixelgram (trade mark). According to preferred aspects of the arrangement disclosed in the international application, the respective diffraction grating of each grating pixel comprises a plurality of reflective or transmissive grooves or lines which are usually curved across a pixel. Groove or line curvature determines both local image intensity, e.g. shading, and local optical structural stability. Groove or line spacing in each pixel determines local colour properties, with non-primary colours generated by a pixel mixing. Average groove or line orientation determines movement or colour effects, and the number of distinct values of average curvature and average spacing may be viewed as defining the Pixelgram palette, by analogy with the language of computer graphics. A further disclosure of a security diffraction grating structure is to be found in international patent publication WO90/07133 (PCT/AU89/00542).

[0003] The present applicant's international patent publication WO93/18419 (PCT/AU93/00102) discloses how selected visually observable effects in the optically variable image may be generated by arraying the pixels in groups within which the pixels are arranged according to a predetermined rule for the pixellated diffraction grating. Thus, for example, multiple sets of different images, or of the same image but different shading or colour, may be produced at different viewing angles.

[0004] The concept of providing multiple optically variable images at different viewing angles, using a pixellated diffractive device in which each pixel contains a sub-pixel corresponding to each image, is also disclosed in US patent 5,032,003. In that case, each diffractive sub-pixel is a straight line grating. This is an example of a more general class of pixellated diffractive structures utilising straight line grating pixels and known by the trademark Kinegram.

[0005] Australian patent application 10499/92 proposes a pixellated diffraction grating structure with three channels which constitute views from different angles of the same image, in order to obtain a stereoscopic image. The gratings may be curved line gratings. A predecessor of this reference is Japanese patent (Kokai) publication 2-72320.

[0006] European patent publication 467601 is concerned with holographic diffraction grating patterns which may include curved line gratings. Overlaid or alternate channels are proposed for providing different images at different angles. The different images may include numerical information and logos.

Summary of the Invention

[0007] The present inventor has now appreciated that the concepts of the aforementioned applications can be further extended to provide diffractive devices which give one or more optically variable images, by fracturing the pixels of each image into sub-pixels and then rearranging and interlacing the sub-pixels so that the sub-pixels cooperatively provide elements of the respective images. In proposing this further development, the inventor has appreciated that he can take advantage of the mathematical theorem in Fourier analysis that the Fourier transform of any diffractive function is translationally invariant.

[0008] According to a first aspect of the present invention there is provided a pixellated diffraction device according to claim 1.

[0009] The invention also provides, in another aspect, a method of designing a multi-component pixellated diffractive device according to claim 19.

[0010] In some prior references, the term "relief structure" is utilised interchangeably with or instead of "diffraction grating" or "diffraction surface structure". The term "diffraction surface structure" is employed herein to indicate a structure which is either reflective or transmissive. Without in any way limiting the scope of "diffraction surface structures", it is noted that such structures may include, for example, line or groove diffraction gratings, small squares, rectangles or polygons.

[0011] By "at least a representation" is meant that the respective integer may be actually formed, or, if not, at least a representation is formed. The representation may be a set of code or data defining the respective integer, e.g. in a computer memory means. The designing steps are preferably carried out in suitably programmed computer operations. The method may advantageously include the step of utilising the derived representation to drive a suitable machine, e.g. an electron beam lithography machine, to form the actual diffractive device.

[0012] Preferably, there are at least two optically variable images, each associated with a respective group of diffractive elements. The images may be the same or similar scenes but differently oriented or of different shading or colour. One or more further groups of sub-

pixels of the device may collectively generate an optically invariable image.

[0013] There are preferably at least four sub-pixels per pixel, but more preferably at least 16 in a 4 x 4 square array of square sub-pixels. The pixels are preferably sufficiently small to be below the resolution limit of a healthy human eye, for example, less than 125 micron on edge and more preferably about 30 to 80, e.g. around 60 micron.

[0014] The diffractive sub-elements are preferably dispersed within each pixel so as to produce a predetermined discernible effect in the corresponding optically variable image. The dispersal of the diffractive elements may be chosen from a predetermined set of selections which therefore defines a mapping palette for the diffractive element array, again by analogy with the language of computer graphics. In a case where, in accordance with international patent publication WO91/03747, the respective diffraction surface structures forming the pixels of the pixellated diffraction surface structure have been formed, e.g. in relation to predetermined variables such as groove or line curvature, groove or line spacing and average groove or line orientation, from a primary palette, the aforementioned mapping palette forms a secondary palette and the diffractive device entails successive selections from both the primary and secondary palettes.

[0015] The diffractive elements within the pixels may involve classes of miniature diffraction gratings of curved and variably spaced grooves, or alternatively elementary arrays of polygon shaped relief structures (pixels within pixels of pixels or SQUOTS) of dimensions of the order of fractions of a micron. In general the transformed representations of the input images may involve classes of groups of diffractive elements. A class of different groups of diffractive elements is defined as a component palette of component pixel types. Since each element of a component palette is itself a group of diffractive elements, each diffractive element can be regarded as a member of a sub palette and hence each component palette is, in this embodiment, a palette of sub palettes (palettes within palettes).

[0016] The invention therefore also provides, in a further aspect, a method of forming a pixellated diffractive device in terms of a multiplicity of diffraction grating pixel palettes characterised in that each pixel palette contains diffraction grating groups and each group M is in itself a sub-pixel palette of N sub-pixel diffractive elements, comprising defining the device by repeating the diffractive elements of each group M at predetermined locations within an array of multiple repeat group locations, the map of repeat group locations for the diffractive elements of each group M being determined by a set of complex mapping relations between said array and a set of invariable image component maps which act cooperatively under the control of the mapping relations to define the diffractive properties of the diffractive device thereby formed on said array, which diffractive proper-

ties cause a multi-component optical effect which is an observable modification of the individual component pixel optical effects generated by each of said sub-pixel diffractive elements.

- 5 [0017] As already indicated, the images generated by the diffractive device may be either optically invariable or optically variable. An image is described herein as "optically variable" where it varies according to the position of observation and "optically invariable" where it remains substantially the same regardless of the position of observation. By "image" in the context of this specification is meant the optical image observed by the naked eye focussed on the diffractive device when it is illuminated by an arbitrarily extended diffuse source of
- 10 [0018] It is an advantage of the present invention that the diffractive device may produce not only a mix of optically variable and optically invariable images but may also produce two or more different kinds of optically variable images. For example, the optical variable images may be of a Pixelgram type (i.e. each pixel is a curved line diffraction grating), a Kinegram type (i.e. each pixel is a straight line diffraction grating), or a mathematical hologram. For each case, the structure of the component mapping palettes is determined by the optical properties of the input images and the required optical properties of the component viewable images generated by the diffractive device.
- 15 [0019] The diffraction device may be provided on a suitable substrate, e.g. a metal foil, and/or may be affixed or formed in a carrier e.g. a currency note, credit card, bank account or ATM card, debit card, security card, charge card or prepaid card.

Brief Description of the Drawings

- 20 [0020] The invention will now be further described, by way of example only, with reference to the accompanying diagrams, in which:

- 25 [0021] Figure 1 is a diagrammatic representation of the formation of an embodiment of diffractive device in accordance with the invention, the diffractive device generating two different optically variable images and utilising Pixelgram-type curved line diffraction gratings; and
- 30 [0022] Figure 2 is a diagrammatic representation of a further embodiment of the invention; and
- 35 [0023] In Figures 1 and 2, the optical effect arising from slight discontinuities or steps in the grating lines is a printer artefact.

Description of Preferred Embodiments

- 40 [0024] Figure 1 depicts one pixel 12,22, for each of

two pixellated diffraction gratings designed in accordance with the principles set out in international patent publication WO91/03747 and intended to produce respective different optically variable images when illuminated. The two pixels are preferably at corresponding coordinate positions in the respective gratings. It will be understood that each of the diffraction gratings does not necessarily physically exist at this stage and that each of the two illustrated pixels may merely have been designed in a computer system and this design set down as a representation in the form of a set of stored data, or more preferably as a code for a selection from a Pixelgram palette, as further discussed hereinafter.

[0022] As explained in international patent publication WO91/03747, the contents of which are incorporated herein by reference, the respective pixellated diffraction gratings are produced from an optically invariable image by first dividing up the image into square pixels (in this case 62.5 micron squares) and assessing the greyness factor, chroma or colour value, or more specifically the greyness factor, chroma or colour value of each pixel in turn. This process is typically carried out by exposing an image to a video camera coupled to a suitable computer system, the greyness factor for each pixel being stored in the computer memory. Groove or line curvature across a pixel determines both local image intensity, e.g. shading and local optical structural stability. Groove or line spacing in each pixel determines local colour properties, with non-primary colours generated by a pixel mixing. Average groove or line orientation determines movement and colour effects, and the number of distinct values of average curvature and average spacing may be viewed as defining the pixelgram palette by analogy with the language of computer graphics. The lines are derived from a function $S_{ij}(x,y)$ as more fully explained in international patent publication WO91/03747.

[0023] It is emphasised that the diffraction grating pixels 12,22 may be pixels of other forms of pixellated diffraction surface structure, e.g. Kinogram-type structures or holograms.

[0024] The next step is to fracture or divide the respective pixels 12,22 into multiple diffractive elements 13,23. A preferred fracturing is a simple $n \times n$ square array, depicted in Figure 1 as a grid overlay 15. In this example, it is a 7×7 array 14,24 of square diffractive elements 13,23 of almost 9 micron sides, a total of 49 diffractive elements.

[0025] The set of diffractive elements is then sampled and displaced or rearranged so that approximately half of the diffractive elements of each set are rearranged in an even, spaced out array 16,26. It will be seen that the two arrays 16,26 are preselected so that, in each array, the retained diffractive elements 13a,23a occupy mutually exclusive positions. The two arrays can then be merged or interlaced to produce the combined pixel 30 in which the diffractive elements 13a,23a define a complete set of sub-pixels 31. In this simple case, sub-pixels 31 consist of diffractive elements 13a,23a.

[0026] This process may then be repeated for all the corresponding pixels of the two designed Pixelgram-type gratings. The resultant set of pixel representations, in the form of suitable data or code, is applied to an electron beam (or "E-beam") lithography system to produce the real grating. E-beam machines are particularly suitable for etching out a diffraction grating microgroove pattern in a substrate in accordance with the supplied data or codes. This aspect of the process is already known and is described, e.g., in International patent publication WO91/03747. In a practical application, a master diffractive device designed to generate characteristic images is made by the above method, and this master is subsequently utilised to produce authorised copies. The grating may be typically written as an array of square cut reflective grooves in a metallised surface, for example PMMA electron resist spin coated onto a chrome coated glass substrate. This substrate may then be processed to produce a gold coated nickel master. For example, a durable metal master of the optimised grating may be obtained by vacuum coating the photoresist master with 2000 angstrom 99.99% gold and electro-depositing a thick layer of nickel to act as a support. After separating from the glass master, this gold coated nickel master may be bonded to a brass block and used as a die for hot pressing of authorised plastic film/foil replica gratings.

[0027] It will be seen from Figure 1 that the design of the arrays 16,26 involves in some instances a substantial rearrangement of the relative positions of the diffractive elements within the pixel. Thus, their relative spatial arrangement is substantially different from their arrangement within original pixels 12,22, in which the diffractive elements co-operate as a contiguous surface structure. For example, the diffractive elements are not merely spread out but occupy different co-ordinate positions in the array. On the one hand, because of the aforementioned theorem of Fourier analysis, this does not effect the integrity of the combined contribution of the diffractive elements or sub-pixels to the corresponding single element or pixel of the viewed optically variable image. On the other hand, observable effects can be produced in the viewed image by particular relative rearrangements of the diffractive elements within a pixel. It is also necessary to take account of the loss of half of the diffractive elements. Thus, for example, it has been realised that in a diffraction grating pixel such as 12, the closest spaced lines towards the left and towards the bottom control the positive order components of the image generated when the grating is illuminated, and the greater spaced region towards the right and top more controls the negative order components. Thus, if the diffractive elements 13a retained in the array 16 are chosen more from the region towards the bottom left corner of pixel 12, there will be a strong positive bias in the contribution to the pixel of the image. A set of selections of different rules for sampling and displacing the diffractive elements 13,23 of the fractured array 14,24

can be predetermined as a secondary palette for the system.

[0028] Some examples of other effects able to be produced by respective selections from the secondary palette include:

- (i) An "RGB" palette consisting of red, green and blue sub-palettes which together act cooperatively to produce a true colour image of the subject at one angle of view. The red, green and blue sub-palettes have carrier frequencies which differ slightly from each other, but the same range of greyness factors;
- (ii) Transparency effects produced by an optically variable Pixelgram-type image in one component with a generalised grating as the second component;
- (iii) An optically invariable image in one component and an optically variable image as the second component. The optically invariable image sub-palette consists of a palette of diffusely scattering pixels of different levels of greyness which produce a static image in zero-order.

[0029] It will now be understood that the general case combining the primary and secondary palettes can be viewed as a set of N component palettes with M1 elements in the first component palette, M2 elements in the second palette ... and MN elements in the Nth component palette.

[0030] It will be appreciated that the fracturing, sampling/displacement and recombination steps in accordance with the preferred practice of the invention allow the production of complex multi-component diffractive devices for which the images have a much smoother appearance, since the effective image resolution can be increased due to the grid size being reduced to the size of a 5 to 15 micron diffractive element or sub-pixel rather than a full, e.g. 60 or so micron, pixel. The effective palette size has also been increased by the fracturing and sampling technique since it allows for the mixing in of additional specialised sub-pixels. Finally, fracturing, sampling and recombination allows for much more flexibility in assigning image element characteristics to the mathematical properties of the sub-pixels.

[0031] A number of further embodiments are possible within the general concept of the invention. For example, the sampling process involved in deriving the array 16,26 from the fractured pixel 14,24 may involve choosing only $(nxn/2)-M$ diffraction elements from each pixel and then interlacing 2M sub-pixels not chosen from the main fractured pixels, with specialised optical properties, to fill the remaining areas of the eventual array. These additional sub-pixels may be designed to contribute special diffuse light effects, zero order diffraction effects or applications-specific colour switch effects to the final image.

[0032] In another alternative embodiment (Figure 2), also indicated as secondary palette (ii) above, a Pixel-

gram-type pixellated diffraction grating 40, shown here as generating an optically variable image recognisable as Albert Einstein, may be combined with a non-pixellated generalised diffraction grating 42 consisting of a curved groove pattern with variable spacings between the grooves. The result is a diffractive device 45 which under illumination produces one or more optically variable semi-transparent images embedded in a background diffractive field. Because the background generalised grating is relatively slowly varying when compared to the very small scale pixellated grating pattern, the background grating pattern will produce relatively large scale zero-order Talbot or Moire fringe patterns when the diffractive device is copied using holographic

- 5 curved groove pattern with variable spacings between the grooves. The result is a diffractive device 45 which under illumination produces one or more optically variable semi-transparent images embedded in a background diffractive field. Because the background generalised grating is relatively slowly varying when compared to the very small scale pixellated grating pattern, the background grating pattern will produce relatively large scale zero-order Talbot or Moire fringe patterns when the diffractive device is copied using holographic
- 10 reflection contact printing techniques. The presence of the strong fringe pattern on the copy will ensure that the copy is markedly different from the original version and hence this type of diffractive device in accordance with an embodiment of the invention will have a high level of optical security.

[0033] It will be appreciated that in each of these embodiments, each of a group M of miniature diffraction grating groups is repeated at predetermined locations within a large array of repeat group locations. The map of these locations for each group M is determined by set of complex mapping relations between the large array and a set of invariable image component maps which act co-operatively under the control of the mapping relations to define the diffractive properties of the diffractive device thereby formed on said large array. The mapping relation required to produce the type of diffractive device described in the preceding paragraph is similar to that required for the device illustrated in Figure 1 except that the generalised grating pattern first needs to

- 25 be redefined mathematically as a set of $n \times m$ small grating elements that can be interpreted as grating pixels able to be combined with the $n \times m$ pixels of the input Pixelgram-type component. This redefinition of the generalised grating can be achieved by overlying the grating with an imaginary $n \times m$ grid and then calculating the average groove spacing and azimuth angle or groove orientation within each grid element or pixel. The generalised grating then becomes a set of $n \times m$ conventional straight line grating pixels of different orientations
- 30 which can be fractured, sampled, displaced and interlaced with corresponding sub-pixels of the corresponding Pixelgram type grating pixels.

[0034] Throughout this specification and the claims which follows, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

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Claims

1. A pixellated diffraction grating providing an optically

variable image, wherein each pixel (30) of the grating comprises an array of sub-pixels (31) in the form of diffractive elements (13a, 23a), wherein the diffractive elements (13a, 23a) of each pixel (30) comprise at least first (13a) and second (23a) groups of diffractive elements, the first group of diffractive elements (13a) from each pixel (12) together defining a diffraction grating for a first image, and the second group of diffractive elements (23a) from each pixel (22) together defining a diffraction grating for a second image, wherein the groups of diffractive elements (13a, 23a) occupy mutually exclusive positions within each pixel, and wherein the first and second groups of diffractive elements (13a, 23a) co-operatively contribute to the image of each pixel (30) of the grating and wherein the diffractive elements (13a, 23a) have a size of 5 to 15 microns.

2. A grating according to claim 1, **characterised in that** first and second images are both optically variable.

3. A pixellated diffraction device according to any preceding claim, **characterised in that** said sub-pixels are so dispersed within each pixel that their relative spatial arrangement is substantially different from their arrangement within said corresponding single pixel, in which the sub-pixels co-operate as a contiguous surface structure.

4. A pixellated diffractive device according to claim 2 or 3, **characterised in that** said optically variable images are the same or similar scenes, but differently orientated or of different shading or colour.

5. A pixellated diffractive device according to any preceding claim, **characterised in that** one or more further groups of sub-pixels of the device co-operatively generate an optically invariable image on illumination of the device.

6. A pixellated diffractive device according to claim 5, further including one or more groups of diffusely scattering sub-pixels which produce an optically invariable image on illumination.

7. A pixellated diffraction device according to any preceding claim, **characterised in that** there are at least 16 sub-pixels per pixel in a 4x4 array of square sub-pixels.

8. A pixellated diffraction device according to any preceding claim, **characterised in that** said pixels are less than 125 microns square.

9. A pixellated diffractive device according to any preceding claim, **characterised in that** said sub-pixels comprise respective miniature diffraction gratings of curved and variably spaced grooves.

10. A pixellated diffractive device according to any preceding claim, **characterised in that** said sub-pixels comprise polygon shaped relief structures of dimensions of the order of fractions of a micron.

11. A pixellated diffractive device according to claim 1, comprising at least three sub-pixel groups, each group including diffractive elements of a single colour, such that the three groups co-operate to produce a true colour image at a particular angle of view.

12. A pixellated diffractive device according to claim 11, **characterised in that** the respective colours of the three groups are red, green and blue.

13. A pixellated diffractive device according to any preceding claim, **characterised in that** each pixel of the device contains two interlaced sub-pixel groups, one group corresponding to a sub-division of a pixel of a pixellated diffractive surface structure in which the pixel grating lines are curved, and the other group corresponding to subdivisions of elementary grid areas of a generalised diffraction grating of curved and variable spaced lines, and further **characterised in that** observed images generated by the diffractive device under any particular light source have the appearance of a generalised diffraction grating of curved and variably spaced lines, such that observed images generated by the diffractive device have the appearance of a generalised diffraction grating pattern seen through a transparent or semi-transparent diffraction image generated by said diffraction surface structure in which the pixel grating lines are curved.

14. A pixellated diffractive device according to claim 13, **characterised in that** the generalised diffraction grating pattern is a relatively slowly varying groove pattern such that any attempted copying of the diffractive device, using the method of holographic contact copying, results in a copied image with overlaid relatively large scale Talbot or Moire fringe effects, not present on the original diffractive device.

15. A pixellated diffractive device according to any preceding claim, **characterised in that** said groups of sub-pixels produce an optically variable image on illumination.

16. A pixellated diffraction device according to any preceding claim, **characterised in that** each pixel of the device contains two interlaced sub-pixel groups, one of which corresponds to the sub-division of the pixels of a first pixellated diffraction surface structure in which the pixel grating lines are curved, and

the other of which corresponds to the subdivision of the pixels of a second pixellated diffraction surface structure in which the pixel grating lines are straight, further **characterised in that** observed images generated by the diffractive device under an illuminating light source have optical characteristics of both said first and second diffractive surface structures.

17. A pixellated diffraction device according to any preceding claim, **characterised in that** each pixel of the device contains two interlaced sub-pixel groups, one of which corresponds to the sub-division of the pixels of a primary pixellated diffraction surface structure in which the pixel grating lines are curved, and the other of which corresponds to the pixel subdivision of a diffusely scattering image device containing multiple levels of greyscale information, such that observed images, generated by the diffraction device, under an illuminating light source, contain both optically variable image information of the primary pixellated diffractive surface structure as well as zero order optically invariable information of the diffusely scattering image device, and further **characterised in that** the zero order optically invariable image information contains similar levels of greyscale information as said levels present in the original diffusely scattering image device.

18. A pixellated diffraction device according to any preceding claim, **characterised in that** the individual diffractive elements making up each sub-pixel are spatially located in said gridded array at locations in said array which are spatially distant from their respective locations within said corresponding pixel.

19. A method of designing a multi-component pixellated diffractive device comprised of a multiplicity of diffractive pixels (30) which are each divided into sub-pixels, which method comprises:
 - (a) designing two or more pixellated diffractive surface structures which, when illuminated, generate respective images.
 - (b) subdividing each pixel (12,22) of each said primary structure into plural diffractive elements (13,23) having a size of 5 to 15 microns, and
 - (c) designing the multi-component pixellated diffractive device as a secondary a multi-component pixellated diffractive device by defining each pixel (30) thereof as a plurality of sub-pixel groups (13a,23a), each sub-pixel group being composed of a first group of diffractive elements (13a) of a spatially corresponding pixel of a first primary pixellated diffractive surface structure intermixed in a gridded array with a

- 5 second group of diffractive elements (23a) of a spatially corresponding pixel of a second primary pixellated diffractive surface structure, the first and second groups of diffractive elements (13a,23a) cooperatively contributing to the image of each pixel (30) of the multi-component device.

- 10 20. A method as claimed in claim 19, wherein the primary structures generate optically variable images.

- 15 21. A method according to claim 19 or 20, further including utilising the derived secondary design to drive a machine, to form the actual diffractive device.

- 20 22. A method according to claim 21, **characterised in that** said machine is an electron beam lithography machine.

- 25 23. A method according to any one of claims 19 to 22, **characterised in that** said sub-pixels of the secondary design are so dispersed within each pixel that their relative spatial arrangement is substantially different from their arrangement within said corresponding single pixel, in which the sub-pixels co-operate as a contiguous surface structure.

- 30 24. A method according to claim 20, **characterised in that** said optically variable images are the same or similar scenes but differently orientated or of different shading or colour.

- 35 25. A method according to any one of claims 19 to 24, **characterised in that** there are at least 16 said sub-pixels in a 4x4 array of square sub-pixels.

- 40 26. A method according to claim 25, **characterised in that** said pixels are less than 125 microns square.

- 45 27. A method according to any one of claims 19 to 26, **characterised in that** said sub-pixels comprise respective miniature diffraction gratings of curved and variably spaced grooves.

- 50 28. A method according to any one of claims 19 to 27, **characterised in that** said sub-pixels comprise polygon shaped relief structures of dimensions of the order of fractions of a micron.

- 55 29. A method according to any one of claims 19 to 28, **characterised in that** said secondary design is such that the respective groups include diffractive elements of three single colours and these groups co-operate to produce a true colour image at a particular angle of view.

30. A method according to claim 29, **characterised in**

that there are respective colour groups for red, green and blue.

31. A method as claimed in claim 19, wherein said diffractive device is formed from a multiplicity of diffraction grating pixel palettes **characterised in that** each pixel palette contains diffraction grating groups and each group M is in itself a sub-pixel palette of N sub-pixel diffractive elements, comprising defining the device by repeating the diffractive elements of each group M at predetermined locations within an array of multiple repeat group locations, the map of repeat group locations for the diffractive elements of each group M being determined by a set of complex mapping relations between said array and a set of invariable image component maps which act co-operatively under the control of the mapping relations to define the diffractive properties of the diffractive device thereby formed on said array, which diffractive properties cause said multi-component optical effect.
32. A pixellated diffraction device formed by the method of any one of claims 19 to 31.
33. A stored set of data defining a pixellated diffractive device according to any one of claims 1 to 18.
34. A computer program product which stores machine readable instructions which, when installed in a computer with an appropriate operating system and memory, carry out the method of any one of claims 19-31.

Patentansprüche

1. Pixeldiffraktionsgitter für ein optisch variables Bild, worin jedes Pixel (30) des Gitters eine Anordnung von Subpixeln (31) in Form von Diffraktionselementen (13a, 23a) umfasst, worin die Diffraktionselemente (13a, 23a) jedes Pixels (30) mindestens erste (13a) und zweite (23a) Gruppen von Diffraktionselementen umfassen, wobei die erste Gruppe von Diffraktionselementen (13a) von jedem Pixel (12) zusammen ein Diffraktionsgitter für ein erstes Bild definieren und die zweite Gruppe von Diffraktionselementen (23a) von jedem Pixel (22) zusammen ein Diffraktionsgitter für ein zweites Bild definieren, worin die Gruppen von Diffraktionselementen (13a, 23a) einander ausschliessende Positionen in jedem Pixel besetzen, und worin die ersten und zweiten Gruppen von Diffraktionselementen (13a, 23a) kooperativ zum Bild jedes Pixels (30) des Gitters beitragen und worin die Diffraktionselemente (13a, 23a) eine Grösse von 5 bis 15 Mikrometern aufweisen.
2. Gitter nach Anspruch 1, **dadurch gekennzeichnet,** dass sowohl erste wie zweite Bilder optisch variabel sind.
3. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass die Subpixel so in jedem Pixel dispergiert sind, dass ihre relative räumliche Anordnung sich im wesentlichen von ihrer Anordnung im entsprechenden Einzelpixel unterscheidet, in dem die Subpixel als zusammenhängende Oberflächenstruktur kooperieren.
4. Pixeldiffraktionsvorrichtung nach Anspruch 2 oder 3, **dadurch gekennzeichnet,** dass die optisch variablen Bilder gleiche oder ähnliche Szenen sind, die aber unterschiedlich orientiert sind oder unterschiedliche Schattierung oder Farbe aufweisen.
5. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass eine oder mehrere weitere Gruppen von Subpixeln der Vorrichtung bei Beleuchtung der Vorrichtung kooperativ ein optisch invariables Bild erzeugen.
6. Pixeldiffraktionsvorrichtung nach Anspruch 5, ferner umfassend eine oder mehrere Gruppen von diffus streuenden Subpixeln, die bei Beleuchtung ein optisch invariables Bild produzieren.
7. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass mindestens 16 Subpixel pro Pixel in einer 4x4-Anordnung von quadratischen Subpixeln vorhanden sind.
8. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass die Pixel weniger als 125 Mikrometer im Quadrat aufweisen.
9. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass die Subpixel entsprechende Miniaturdiffraktionsgitter mit geschwungenen und variabel beabstandeten Rillen umfassen.
10. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** dass die Subpixel polygonförmige Reliefstrukturen mit Abmessungen in der Größenordnung von Mikrometerbruchteilen umfassen.
11. Pixeldiffraktionsvorrichtung nach Anspruch 1, umfassend mindestens drei Subpixelgruppen, wobei jede Gruppe Diffraktionselemente einer einzigen Farbe aufweist, derart, dass die drei Gruppen ko-

operieren, um in einem bestimmten Blickwinkel ein echtfarbiges Bild zu produzieren.

12. Pixeldiffraktionsvorrichtung nach Anspruch 11, dadurch gekennzeichnet, dass die entsprechenden Farben in den drei Gruppen Rot, Grün und Blau sind.

13. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass jedes Pixel der Vorrichtung zwei verknüpfte Subpixelgruppen enthält, wobei eine Gruppe einer Subdivision eines Pixels einer Pixeldiffraktionsoberflächenstruktur entspricht, in der die Pixelgitterlinien geschwungen sind, und die andere Gruppe Subdivisionen von Elementargitterrasterbereichen eines allgemeinen Diffraktionsgitters von geschwungenen und variabel beabstandeten Linien entspricht, und ferner dadurch gekennzeichnet, dass durch die Diffraktionsvorrichtung erzeugte unter einer bestimmten Lichtquelle sichtbare Bilder das Aussehen eines allgemeinen Diffraktionsgitters von geschwungenen und variabel beabstandeten Linien aufweist, derart, dass durch die Diffraktionsvorrichtung erzeugte sichtbare Bilder das Aussehen eines allgemeinen Diffraktionsgittermusters aufweist, gesehen durch ein transparentes oder halbtransparentes Diffraktionsbild erzeugt durch die Diffraktionsoberflächenstruktur, in der die Pixelgitterlinien geschwungen sind.

14. Pixeldiffraktionsvorrichtung nach Anspruch 13, dadurch gekennzeichnet, dass das allgemeine Diffraktionsgittermuster ein relativ langsam sich veränderndes Rillenmuster ist, derart, dass ein versuchtes Kopieren der Diffraktionsvorrichtung, unter Verwendung des holographischen Kontaktkopierverfahrens, zu einem kopierten Bild mit überlagerteren relativ grossen Talbot- oder Moire-Effekten ist, die in der Originaldiffraktionsvorrichtung nicht vorhanden sind.

15. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Subpixelgruppen bei Beleuchtung ein optisch variables Bild produzieren.

16. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass jedes Pixel der Vorrichtung zwei verknüpfte Subpixelgruppen enthält, deren eine der Subdivision der Pixel einer ersten Pixeldiffraktionsoberflächenstruktur entspricht, in der die Pixelgitterlinien geschwungen sind, und deren andere der Subdivision der Pixel einer zweiten Pixeldiffraktionsoberflächenstruktur entspricht, in der die Pixellinien gerade sind, ferner dadurch gekennzeichnet, dass die unter einer Beleuchtungslichtquelle durch die

Diffraktionsvorrichtung erzeugten sichtbaren Bilder optische Eigenschaften sowohl der ersten wie der zweiten Diffraktionsoberflächenstrukturen aufweisen.

17. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass jedes Pixel der Vorrichtung zwei verknüpfte Subpixelgruppen enthält, deren eine der Subdivision der Pixel einer primären Pixeldiffraktionsoberflächenstruktur entspricht, in der die Pixelgitterlinien geschwungen sind, und deren andere der Pixelsubdivision einer diffus streuenden Bildvorrichtung entspricht, die zahlreiche Stufen der Grauskaleninformation enthält, derart, dass von der Diffraktionsvorrichtung unter einer Beleuchtungslichtquelle erzeugte sichtbare Bilder sowohl optisch variable Bildinformation der primären Pixeldiffraktionsoberflächenstruktur als auch optisch invariable Information nullter Ordnung der diffus streuenden Bildvorrichtung enthalten, und ferner dadurch gekennzeichnet, dass die optisch invariable Bildinformation der nullten Ordnung ähnliche Stufen der Grauskaleninformation enthält wie die in der diffus streuenden Originalbildvorrichtung vorhandenen Stufen.

18. Pixeldiffraktionsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die einzelnen Diffraktionselemente, die jedes Subpixel bilden, räumlich in der Gitterrasteranordnung an Orten angeordnet sind, die räumlich von ihren entsprechenden Orten im entsprechenden Pixel fern sind.

19. Verfahren zur Konstruktion einer Mehrkomponenten-Pixeldiffraktionsvorrichtung gebildet aus einer Vielzahl von Diffraktionspixeln (30), die jedes in Subpixel unterteilt sind, wobei das Verfahren umfasst:

- (a) Konstruieren von zwei oder mehr Pixeldiffraktionsoberflächenstrukturen, die beim Beleuchten entsprechende Bilder erzeugen,
- (b) Unterteilen jedes Pixels (12, 22) jeder der primären Strukturen in viele Diffraktionselemente (13, 23) mit einer Grösse von 5 bis 15 Mikrometern, und
- (c) Konstruieren der Mehrkomponenten-Pixeldiffraktionsvorrichtung als sekundäre Multi-komponenten-Pixeldiffraktionsvorrichtung durch Definieren jedes Pixels (30) darin als eine Vielzahl von Subpixelgruppen (13a, 23a), wobei jede Subpixelgruppe gebildet ist aus einer ersten Gruppe von Diffraktionselementen (13a) eines räumlich entsprechenden Pixels einer ersten primären Pixeldiffraktionsoberflächenstruktur vermischt in einer Gitterrasteranordnung mit einer zweiten Gruppe von Diffrak-

tionselementen (23a) eines räumlich entsprechenden Pixels einer zweiten primären Pixel-diffraktionsoberflächenstruktur, wobei die erste und zweite Gruppe von Diffraktionselementen (13a, 23a) kooperativ zum Bild jedes Pixels (30) der Multikomponentenvorrichtung beitragen.

20. Verfahren nach Anspruch 19, worin die primären Strukturen optisch variable Bilder erzeugen.

21. Verfahren nach Anspruch 19 oder 20, ferner umfassend die Nutzung der gewonnenen zweiten Konstruktion zum Betrieb einer Maschine, um die tatsächliche Diffraktionsvorrichtung auszubilden.

22. Verfahren nach Anspruch 21, **dadurch gekennzeichnet, dass** die Maschine eine Elektronenstrahlolithographiemaschine ist.

23. Verfahren nach einem der Ansprüche 19 bis 22, **dadurch gekennzeichnet, dass** die Subpixel der zweiten Konstruktion so in jedem Pixel dispergiert sind, dass ihre relative räumliche Anordnung sich im wesentlichen von ihrer Anordnung im entsprechenden Einzelpixel unterscheidet, in dem die Subpixel als zusammenhängende Oberflächenstruktur kooperieren.

24. Verfahren nach Anspruch 20, **dadurch gekennzeichnet, dass** die optisch variablen Bilder gleiche oder ähnliche Szenen aufweisen, aber unterschiedlich orientiert oder in unterschiedlicher Schattierung oder Farbe.

25. Verfahren nach einem der Ansprüche 19 bis 24, **dadurch gekennzeichnet, dass** mindestens 16 Subpixel in einer 4x4-Anordnung von quadratischen Subpixelen vorhanden sind.

26. Verfahren nach Anspruch 25, **dadurch gekennzeichnet, dass** die Pixel weniger als 125 Mikrometer im Quadrat aufweisen.

27. Verfahren nach einem der Ansprüche 19 bis 26, **dadurch gekennzeichnet, dass** die Subpixel entsprechende Miniaturdiffraktionsgitter aus geschwungenen und variabel beabstandeten Rillen umfassen.

28. Verfahren nach einem der Ansprüche 19 bis 27, **dadurch gekennzeichnet, dass** die Subpixel polygonförmige Reliefstrukturen mit Abmessungen in der Größenordnung von Mikrometerbruchteilen umfassen.

29. Verfahren nach einem der Ansprüche 19 bis 28, **dadurch gekennzeichnet, dass** die sekundäre Konstruktion derart ist, dass die entsprechenden Gruppen Diffraktionselemente von drei einzelnen Farben aufweisen und diese Gruppen kooperieren, um bei einem bestimmten Blickwinkel ein echtfarbiges Bild zu produzieren.

30. Verfahren nach Anspruch 29, **dadurch gekennzeichnet, dass** entsprechende Farbgruppen für Rot, Grün und Blau vorhanden sind.

31. Verfahren nach Anspruch 19, worin die Diffraktionsvorrichtung aus einer Vielzahl von Diffraktionsgitter-pixelpaletten gebildet wird, **dadurch gekennzeichnet, dass** jede Pixelpalette Diffraktionsgittergruppen enthält und jede Gruppe M in sich eine Subpixelpalette von N Subpixeldiffraktionselementen ist, umfassend Definieren der Vorrichtung durch Wiederholen der Diffraktionselemente jeder Gruppe M an bestimmten Orten in einer Anordnung von zahlreichen Wiederholungsgruppenorten, wobei das Raster der Wiederholungsgruppenorte für die Diffraktionselemente jeder Gruppe M durch einen Satz komplexer Rasterbeziehungen zwischen der Anordnung und einem Satz invariabler Bildkomponentenraster bestimmt wird, die kooperativ unter dem Einfluss der Rasterbeziehungen wirken, um die Diffraktionseigenschaften der dadurch auf der Anordnung ausgebildeten Diffraktionsvorrichtung zu definieren, welche Diffraktionseigenschaften den mehrkomponentigen optischen Effekt bewirken.

32. Pixeldiffraktionsvorrichtung gebildet durch das Verfahren nach einem der Ansprüche 19 bis 31.

33. Gespeicherter Datensatz, der eine Pixeldiffraktionsvorrichtung nach einem der Ansprüche 1 bis 18 definiert.

34. Computerprogrammprodukt, das maschinenlesbare Instruktionen speichert, die, wenn sie in einem Computer mit einem geeigneten Betriebssystem und Speicher installiert sind, das Verfahren nach einem der Ansprüche 19 bis 31 ausführen.

45 **Revendications**

1. Réseau de diffraction pixellisé fournissant une image optiquement variable, dans lequel chaque pixel (30) du réseau comprend un ensemble de sous-pixels (31) sous la forme d'éléments diffractifs (13a, 23a), dans lequel les éléments diffractifs (13a, 23a) de chaque pixel (30) comprennent au moins un premier groupe (13a) et un deuxième groupe (23a) d'éléments diffractifs, le premier groupe d'éléments diffractifs (13a) de chaque pixel (12) définissant ensemble un réseau de diffraction pour une première image, et le deuxième groupe d'éléments diffractifs

(23a) de chaque pixel (22) définissant ensemble un réseau de diffraction pour une deuxième image, dans lequel les groupes d'éléments diffractifs (13a, 23a) occupent des positions mutuellement exclusives dans chaque pixel, et dans lequel les premier et deuxième groupes d'éléments diffractifs (13a, 23a) contribuent de manière coopérative à l'image de chaque pixel (30) du réseau et dans lequel les éléments diffractifs (13a, 23a) ont une taille de 5 à 15 microns.

2. Réseau selon la revendication 1 **caractérisé en ce que** ces première et deuxième images sont toutes les deux optiquement variables.

3. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** lesdits sous-pixels sont dispersés dans chaque pixel de telle manière que leur disposition spatiale relative est实质iellement différente de leur disposition dans ledit seul pixel correspondant dans lequel les sous-pixels coopèrent comme une structure de surface contiguë.

4. Dispositif diffracteur pixellisé selon la revendication 2 ou 3, **caractérisé en ce que** lesdites images optiquement variables sont les mêmes scènes ou des scènes similaires mais orientées différemment ou d'une teinte ou couleur différente.

5. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** un ou plusieurs autres groupes de sous-pixels du dispositif génèrent de manière coopérative une image optiquement invariable lors de l'éclairage du dispositif.

6. Dispositif diffracteur pixellisé selon la revendication 5 comprenant en outre un ou plusieurs groupes de sous-pixels se dispersant de manière diffuse qui produisent une image optiquement invariable lors de l'éclairage.

7. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce qu'il y a au moins 16 sous-pixels par pixel dans un ensemble de sous-pixels carrés de 4 X 4.**

8. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** lesdits pixels font moins de 125 microns carrés.

9. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** lesdits sous-pixels comprennent des réseaux de diffraction miniatures respectifs de raies courbes et espacées de manière variable.

10. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** lesdits sous-pixels comprennent des structures en relief en forme de polygone de dimensions de l'ordre de fractions d'un micron.

11. Dispositif diffracteur pixellisé selon la revendication 1 comprenant au moins trois groupes de sous-pixels, chaque groupe incluant des éléments diffractifs d'une seule couleur, de sorte que les trois groupes coopèrent pour produire une véritable image en couleur sous un angle de vue particulier.

12. Dispositif diffracteur pixellisé selon la revendication 11, **caractérisé en ce que** les couleurs respectives des trois groupes sont le rouge, le vert et le bleu.

13. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** chaque pixel du dispositif contient deux groupes de sous-pixels entrelacés, un groupe correspondant à une subdivision d'un pixel d'une structure de surface de diffraction pixellisée dans laquelle les lignes du réseau de pixels sont courbes et l'autre groupe correspondant à des subdivisions de régions élémentaires d'un réseau de diffraction généralisé de lignes courbes et espacées de manière variable, et **caractérisé en outre en ce que** les images observées générées par le dispositif diffracteur sous une quelconque source lumineuse particulière ont l'apparence d'un réseau de diffraction généralisé de lignes courbes et espacées de manière variable, de sorte que les images observées générées par le dispositif diffracteur ont l'apparence d'une configuration de réseau de diffraction généralisé vu au travers d'une image diffractée transparente ou semitransparente générée par ladite structure de surface de diffraction dans laquelle les lignes du réseau de pixels sont courbes.

14. Dispositif diffracteur pixellisé selon la revendication 13, **caractérisé en ce que** la configuration du réseau de diffraction généralisé est une configuration de raies variant relativement lentement de sorte que toute tentative de copie du dispositif diffracteur, en utilisant la méthode de copie holographique par contact, a pour résultat une image copiée avec des effets superposés de franges moirées ou de Talbot à relativement grande échelle qui ne sont pas présents sur le dispositif diffracteur original.

15. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** lesdits groupes de sous-pixels produisent une image optiquement variable lors de l'éclairage.

16. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce**

que chaque pixel du dispositif contient deux groupes de sous-pixels entrelacés, dont l'un correspond à la subdivision des pixels d'une première structure de surface de diffraction pixellisée dans laquelle les lignes du réseau de pixels sont courbes et dont l'autre correspond à la subdivision des pixels d'une deuxième structure de surface de diffraction pixellisée dans laquelle les lignes du réseau de pixels sont droites, **caractérisé en outre en ce que** les images observées générées par le dispositif diffracteur sous une source lumineuse d'éclairage ont des caractéristiques optiques desdites première et deuxième structures de surface de diffraction pixellisée.

17. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** chaque pixel du dispositif contient deux groupes de sous-pixels entrelacés, dont l'un correspond à la subdivision des pixels d'une structure de surface de diffraction pixellisée primaire dans laquelle les lignes du réseau de pixels sont courbes et dont l'autre correspond à la subdivision des pixels d'un dispositif d'images à dispersion diffuse contenant de multiples niveaux d'information sur l'échelle des gris, de sorte que des images observées, générées par le dispositif diffracteur, sous une source lumineuse d'éclairage, contient des informations sur les images optiquement variables de la structure de surface de diffraction pixellisée primaire ainsi que des informations optiquement invariables d'ordre zéro du dispositif d'images à dispersion diffuse, et **caractérisé en outre en ce que** les informations sur les images optiquement invariables d'ordre zéro contiennent des niveaux similaires d'information sur l'échelle des gris que lesdits niveaux présents dans le dispositif d'images à dispersion diffuse original.

18. Dispositif diffracteur pixellisé selon une quelconque des revendications précédentes, **caractérisé en ce que** les éléments diffractifs individuels constituant chaque sous-pixel sont situés spatialement dans le dit ensemble réticulaire à des emplacements dans ledit ensemble qui sont spatialement distants de leurs emplacements respectifs dans lesdits pixels correspondants.

19. Procédé pour concevoir un dispositif diffracteur pixellisé à composants multiples constitué d'une multiplicité de pixels diffractifs (30) qui sont chacun divisé en sous-pixels, laquelle méthode consiste:

- (a) à concevoir deux ou plusieurs structures de surface de diffraction pixellisée qui, quand elles sont éclairées, génèrent des images respectives,
- (b) à subdiviser chaque pixel (12, 22) de cha-

que dite structure primaire en plusieurs éléments diffractifs (13, 23) ayant une taille de 5 à 15 microns, et

5 (c) à concevoir le dispositif diffracteur pixellisé à composants multiples comme un dispositif diffracteur pixellisé secondaire à composants multiples en définissant chaque pixel (30) de celui-ci comme une pluralité de groupes (43a, 25 23a) de sous-pixels, chaque groupe de sous-pixels étant composé d'un premier groupe d'éléments diffractifs (13a) d'un pixel spatialement correspondant d'une première structure de surface de diffraction pixellisée primaire mélangé dans un ensemble réticulaire avec un deuxième groupe d'éléments diffractifs (23a) d'un pixel spatiallement correspondant d'une deuxième structure de surface de diffraction pixellisée primaire, les premier et deuxième groupes d'éléments diffractifs (13a, 23a) contribuant de manière coopérative à l'image de chaque pixel (30) du dispositif à composants multiples.

20. Procédé selon la revendication 19, dans lequel les 25 structures primaires génèrent des images optiquement variables.

21. Procédé selon la revendication 19 ou 20 comprenant en outre l'utilisation de la conception secondaire dérivée pour piloter une machine pour former le dispositif diffracteur effectif.

22. Procédé selon la revendication 21, **caractérisé en ce que** ladite machine est une machine de lithographie à faisceaux d'électrons.

23. Procédé selon une quelconque des revendications 19 à 22, **caractérisé en ce que** lesdits sous-pixels de la conception secondaire sont dispersés dans chaque pixel de telle manière que leur disposition spatiale relative est substantiellement différente de leur disposition dans ledit seul pixel correspondant dans lequel les sous-pixels coopèrent comme une structure de surface contiguë.

24. Procédé selon la revendication 20, **caractérisé en ce que** lesdites images optiquement variables sont les mêmes scènes ou des scènes similaires mais orientées différemment ou d'une teinte ou couleur différente.

25. Procédé selon une quelconque des revendications 19 à 24, **caractérisé en ce qu'il y a au moins 16 dits sous-pixels dans un ensemble de sous-pixels carrés de 4 X 4.**

26. Procédé selon la revendication 25, **caractérisé en ce que** lesdits pixels font moins de 125 microns car-

rés.

27. Procédé selon une quelconque des revendications 19 à 26, **caractérisé en ce que** lesdits sous-pixels comprennent des réseaux de diffraction miniatures respectifs de raies courbes et espacées de manière variable. 5

28. Procédé selon une quelconque des revendications 19 à 27, **caractérisé en ce que** lesdits sous-pixels comprennent de structures en relief en forme de polygone de dimensions de l'ordre de fractions d'un micron. 10

29. Procédé selon une quelconque des revendications 19 à 28, **caractérisé en ce que** ladite conception secondaire est telle que les groupes respectifs comprennent des éléments diffractifs de trois couleurs uniques et ces groupes coopèrent pour produire une véritable image en couleur sous un angle de vue particulier. 15 20

30. Procédé selon la revendication 29, **caractérisé en ce qu'il y a** des groupes de couleur respectifs pour le rouge, le vert et le bleu. 25

31. Procédé selon la revendication 19 dans lequel ledit dispositif diffracteur est formé par une multiplicité de palettes de pixels de réseaux de diffraction, **caractérisé en ce que** chaque palette de pixels contient de groupes de réseaux de diffraction et chaque groupe M est en soi une palette de sous-pixels de N éléments diffractifs de sous-pixels, consistant à définir le dispositif en répétant les éléments diffractifs de chaque groupe M à des emplacements pré-déterminés dans un ensemble d'emplacements multiples de groupes répétés, la carte des emplacements des groupes répétés pour les éléments diffractifs de chaque groupe M étant déterminée par un jeu de relations cartographiques complexes entre ledit ensemble et un jeu de cartes de composants d'images invariables qui coopèrent sous le contrôle des relations cartographiques pour définir les propriétés de diffraction du dispositif diffracteur ainsi formé sur ledit ensemble, lesquelles propriétés de diffraction engendrent ledit effet optique à composants multiples. 30 35 40 45

32. Dispositif diffracteur pixellisé formé par le procédé selon l'une quelconque des revendications 19 à 21. 50

33. Jeu de données stocké définissant un dispositif diffracteur pixellisé selon une quelconque des revendications 1 à 18. 55

34. Programme informatique qui stocke des instructions lisibles par machine et qui, quand il est installé sur un ordinateur avec un système d'exploitation

approprié et une mémoire appropriée, exécute le procédé selon une quelconque des revendications 19 à 31.

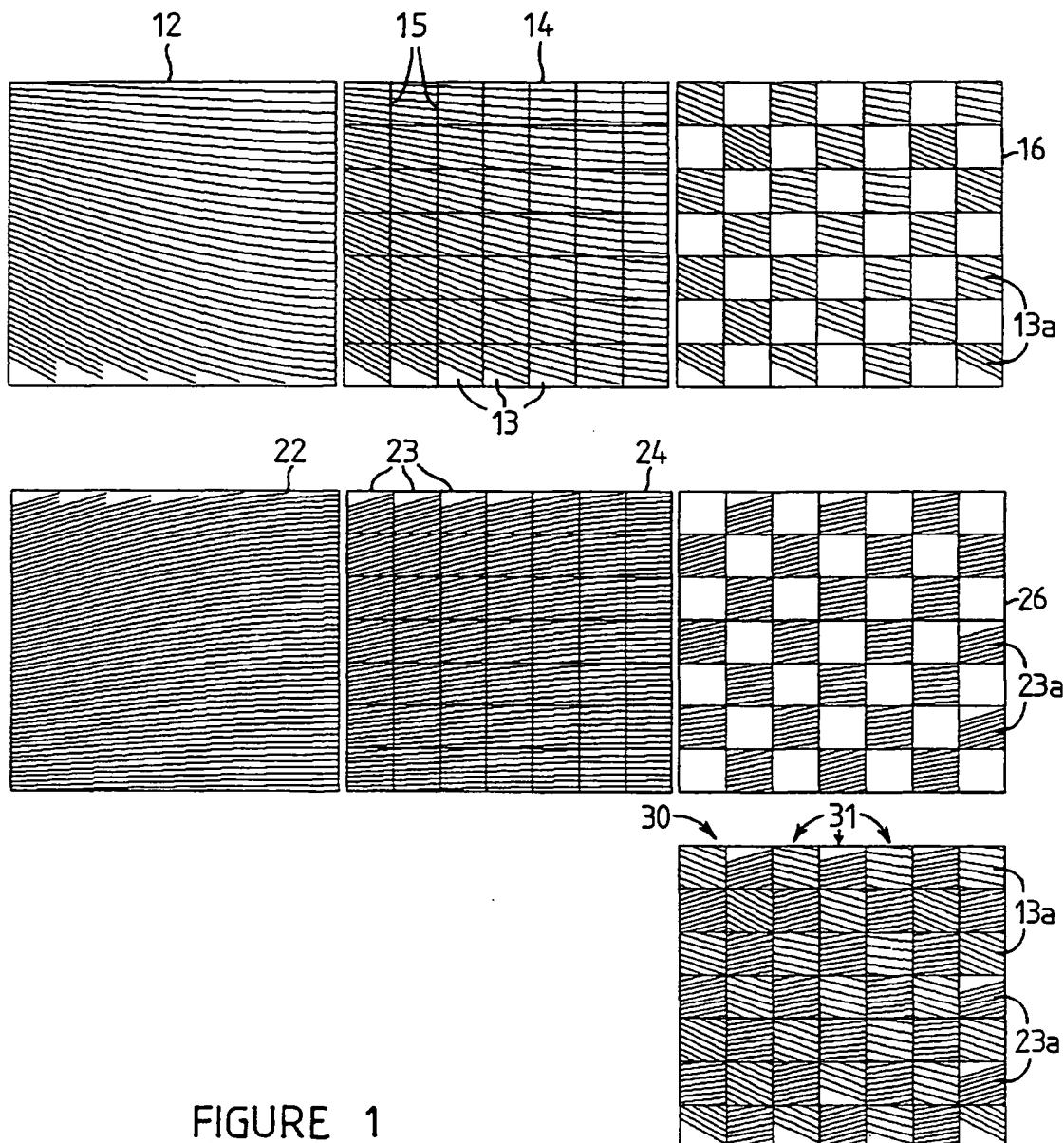


FIGURE 1

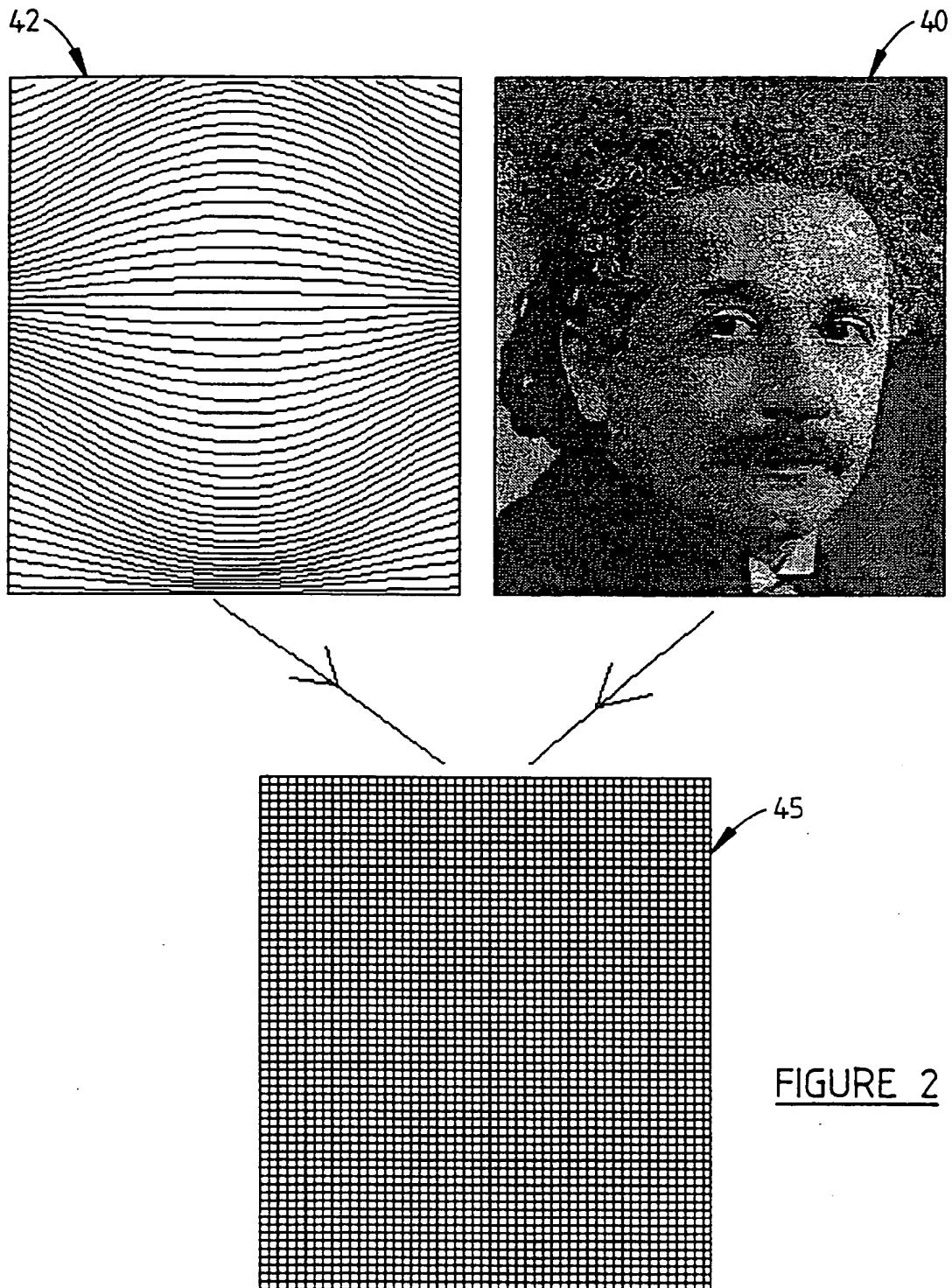


FIGURE 2